ELECTRONIC FUNDS TRANSFER TECHNOLOGY

A CANADIAN PERSPECTIVE

Working Paper #4

S. Paula Mitchell

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This background paper is one of a series which has been developed in connection with a research project directed by Professor Richard H. McLaren. It is directed at identifying specific issues within a designated topic. The research project was designed to identify the "Policy and Legislative Responses to Electronic Funds Transfer" from a provincial perspective.

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GLOSSARY OF ACRONYMS

- Point-of-Sale Systems (POS)
- Clearing House Interbank Payments System (CHIPS)
- Banque Canadienne Nationale (BCN)
- Demand-deposit accounting (DDA)
- Electronic Data Processing (edp)
- Systems Network Architecture (SNA)
- Synchronous Data Link Control (SDLC)
- Distributed Network Architecture (DNA)
- Automated Teller Machines (ATM)
- Personal Identification Number (PIN)
- Financial Transaction Terminal (FTT)
- Data Base Management Systems (DBMS)
- Customer Information Files (CIF)
- Trans-Canada Telephone System (TCTS)
- Consultative Committee on International Telephony and Telegraphy (CCITT)
- Standard Network Access Protocol (SNAP)
- Network Interface Machine (NIM)
- American National Standards Institute (ANSI)
- Canadian Telecommunications Carriers Association (CTCA)
- Society for Worldwide International Financial Transactions (SWIFT)
- Trans-Canada Computer Communications Network (TCCN)
- Canadian National/Canadian Pacific Telecommunications (CN/CP)
- Canadian Radio-television and Telecommunications Commission (CRTC)

I. STATUS OF EFT TECHNOLOGY: OVERVIEW

It is generally agreed that the basic technology for the development of national and international integrated EFT systems exists. Rising, labor-intensive costs of processing and clearing ever-increasing volumes of financial transaction information by existing systems is causing an increased movement toward the utilization of this technology on an increasing scale and across a broadening scope of financial applications. It is also evident that the development of integrated EFT systems is taking the form of an evolutionary, rather than revolutionary process. A report on the fifth international Conference on Payment Systems, held in the summer of 1977, and including representation from Canada and 27 other countries, indicates that the debate over the technological feasibility of on-line real time banking systems has come to an end.[1] Emphasis is now shifting to problems of organization, configuration, cost-effectiveness, security and consumer acceptance. EFT equipment and communications requirements must be available at a cost which renders real time, on-line services cost-effective within an overall technological configuration which ensures reliability, security, and maintenance of present levels of customer convenience.

Dramatic reductions in the cost of storing and processing data have been afforded by the development of current generation mass storage devices: "A typical computer configuration costing $100,000 in annual rental in 1975 would probably be able to perform ten times the work of a typical configuration which cost the same amount in 1965."[2] The economies and efficiencies afforded the banking industry through utilization of electronic data processing for internal record keeping functions are established and have laid the foundations for EFT developments.

However, capital requirements for full-scale integrated EFT are very high. The enormity of capital requirements is highlighted in a report prepared for the U.S. Federal Communications Commission.[3] A computer/communications model for the U.S. to the year 1986 was developed with the intent of quantifying the maximum realizable impact of data communications; the three services expected to make a major impact over the next decade, EFTS, Point-of-Sale Systems (POS), and electronic mail were included in the model. Based on current data, the study projected traffic flows, network costs, terminal and computing costs, and expected revenues for each of these services. Of particular interest is the following finding: "The capital requirements for terminals, computing hardware, and service software are very high. The accumulation of this capital could become a major constraint on implementation." To achieve a national integrated POS-EFTS network linking all banks and retail outlets by 1986, an investment of $80 billion in terminals and other computing equipment alone is projected. An overall average POS processing cost of 5¢ per transaction is estimated, but this figure is highly traffic dependent and would be much higher in a low volume situation. The report stresses that unless costs are substantially reduced it is unlikely that any more than one-third of retail establishments would be participants in POS by 1986. While these figures are projections and apply to the U.S. situation, they put in perspective the vastness of EFT undertakings from an economic viewpoint, both in terms of capital investment requirements by financial institutions and retailers, and potential revenues to the computer/communications industry.

As yet, the profitability of current point-of-sale and automated teller machine ventures which have been undertaken mainly in the U.S., has not been established; to the contrary, many institutions can justify such EFT programs solely on the grounds of their drawing power for other services offered.[4] Per unit costs of equipment, programming manhours required to build in a range of transactional support modules, and communications equipment costs dictate that high volume usage is required to make such programs cost-effective.

The recent Quantum Science Corp. study on EFT suggests that national EFT in the U.S. is farther down the road than was expected in the early 1970's, and that cheques and credit cards will continue to serve as the prime modes of funds transfer for some time.[5]

While these studies shed a rather conservative light on the short-term expectations for national EFT in the U.S., it is clear from present levels of implementation that EFT technology is well entrenched. Many large-scale automated clearing houses and statewide Electronic Funds Networks such as the Nebraska Electronic Transfer System which links 66% of the state's banks, have been implemented. The New York Clearing House Association has been operating an automated clearing house since 1970. The objectives of the Clearing House Interbank Payments System (CHIPS) are the automation of interbank transfers, elimination of paper cheques and the automated production of day-end balances for participating clearing banks. The system has now succeeded in eliminating almost all cheques in its interbank payment transfers.[6]

There have been no comparable studies undertaken on the status of EFT development in Canada. The Computer/Communications Secretariat projects that EFTS will have a major impact upon computer/communications by the mid 1980's, but admits that no statistics are available to back up such a projection. A study undertaken by the Communications Research Centre of the Federal Department of Communications during May and November of 1976 confirms that there is a high level of computer/communications activity within the Canadian financial community. The study surveyed 74 companies representing the "leading edge" of computer/communications users in Canada. Of the 74 companies, 21 were financial institutions with total assets of $80 billion accounting for 60% of the total financial assets of the Financial Post's top 50 Financial Institutions.

While the sample was biased in favour of major users of computer/ communications, and results must be seen in this light, data were compared to other available information and proved to be consistent.[7]

Financial institutions in the sample spent an average of $8.1 million on data processing or 0.2% of assets.[8] The growth in data processing costs for financial institutions from 1975 to 1976 was 17.8% as compared to a 15% increase over the same period for the other industries surveyed. Whereas personnel costs represent the largest expenditure category for the sample as a whole, financial institutions allocate the largest proportion of their data processing budgets to hardware and communications (44% in 1975 and 43% in 1976 compared to overall averages of 36.4% and 37.5%); this differentiation is attributed to the fact that financial institutions are comparatively high users of on-line terminals. Close to 50% (9,768) of all terminals reported by the total sample (19,768) are on-line banking terminals. Financial institutions reported that they expect to double the number of their terminals to 20,000 by 1980.

Of the 9,768 on-line banking terminals reported, 39.36% are located in Ontario, and 38.5% are located in Quebec for a total of 77.86% for the two provinces. Although these figures suggest that on-line banking is as yet heavily concentrated geographically, they must be seen relative to the regional concentration of banks. Of the 7,276 total branches operated by the chartered banks of Canada 1,585 or 21.78% are located in Quebec, and 2,830 or 38.89% are located in Ontario, for a total of 60.67% of all bank branches.[9]

The average percentage increase for expenditures on hardware and communications by the financial institutions represent in the survey over 1975-76 was 16.8%; given that they are established computer users this is a substantial increase. An average increase of 19.9% was projected by the financial institutions for 1976-77.

II. DEVELOPMENT OF ON-LINE BANKING IN CANADA

The development of automated systems to process financial information in Canada has to date centred on two basic areas; (1) the development of in-house data processing facilities by financial institutions and the linking of branches to these facilities through on-line systems; (2) the development of mechanized methods for check handling.[10] On-line banking represents the first major step toward EFT systems in Canada, and provides the base from which future systems will evolve.

The on-line, real-time mode of data processing can best be understood in contrast to batch processing. In a batch processing mode, data is accumulated and master files on a computer are updated periodically; the frequency of update is determined according to an assessment of the volume of update data and the necessity to have current, up-to-date information. On-line, real-time systems utilize hardware and software that enable data to be dispatched from a terminal to a central processing unit and back to the terminal in the form of an immediate response. Files are updated as transactions occur, and the results of updating are transmitted back to the terminal in a responsive 'conversational' manner. In addition to this characteristic of responsiveness, on-line real-time applications allow data to be put into computer-readable form directly, at the time a transaction takes place. This eliminates the need for manual transcription of information and then subsequent entry of recorded information into the computing system.

The majority of financial institution information is generated by branch activity. The linking of branches to central or regional computer processing centres using on-line real-time systems provides banks with the means to significantly reduce branch-bank paper flow. In addition to improving internal efficiency on-line banking provides the potential for improvements in the level of customer services.

Because most savings account transactions are immediate over-the-counter transactions, and therefore are not amenable to batch processing systems, Canadian financial institutions first utilized on-line systems for savings applications. During the late 1960's and early 1970's, because of the risk and complexity of implementing such systems, financial institutions primarily used computer manufacturer data systems. Terminals located in branches were connected by telecommunication lines to computers in data processing centres operated by manufacturers such as IBM, NCR, Burroughs and Honeywell.[11] As the cost/benefits of on-line branch systems were established, financial institutions either purchased or developed their own software and undertook the support of their on-line systems on an in-house basis.

The Banque Canadienne Nationale (BCN) was the first Canadian chartered bank to control its on-line savings system on an in-house basis, and its present level of development is representative of the various levels of on-line banking among Canadian financial institutions.

In 1970, BCN acquired four Burroughs TC700 terminals and found that these intelligent programmable terminals provided the capability to build an on-line savings network on its own computers with in-house software. BCN's electronic data processing (edp) staff in co-operation with Burroughs, developed its own customized software which would support both the terminal functions and central computer processing functions.

At this time, BCN has extended its on-line system to most of its branches. Three hundred teller terminals are connected on-line to Burroughs computers in BCN data processing centres in Montreal and Quebec City. The terminals are now used for both savings and demand-deposit accounting (DDA). Savings transactions such as deposit-withdrawals, or account inquiries are affected in a real-time mode. Either a query or transaction information is transmitted to the computer on which files are maintained and response and/or account updating is effected immediately. For DDA transactions, terminals can be employed to capture over-the-counter withdrawals, and to query

customer account status. In addition, information from cheques returned to the branch through the clearing system can be keyed into the teller terminal and transmitted to a computer holding the account files for subsequent debiting and crediting of customer accounts. As is the case with other Canadian banks, BCN's immediate priority is to develop a complete network allowing every branch to send or obtain information on an on-line real-time basis.[12]

Some smaller Canadian financial institutions are utilizing the data processing services of computer service bureaus for the full range of their data processing requirements. Since 1975, Niagara Credit Union has utilized the data processing services of Canada Systems Group in Mississauga, Ontario, and as yet operates in a batch mode. All transactions are entered into branch terminals and transmitted from the head office to the service bureau's host computer, which maintains Niagara's files. These files contain information on accounts, loans, RRSP, RHOSP and guaranteed deposit certificates. The host computer produces a printout for each branch which contains up-dates for all branch accounts, reflecting all deposits, loans, loan charges and daily interest.

Niagara is planning a transition to Canada Systems Group's on-line banking service to support its growing volume of transactions.[13] On-line systems and emerging EFT applications in Canada are further described in the context of EFT systems and hardware in the following sections.

III. EFT SYSTEMS, HARDWARE AND SOFTWARE

A. Financial Computer/Communications Systems

With the rapid evolution of computer/communications network applications over the last decade, computer hardware suppliers have

undertaken the development of integrated networking systems to meet customer's networking requirements in a systemic fashion. These systems configure a range of supplier terminals, data processing, and communications processing equipment, within an integrated, standardized network design or 'architecture'. Most major computer suppliers are now developing specialized communications systems for on-line real-time banking and point-of-sale applications. Two such systems, both of which are being employed by Canadian financial institutions are described below.

1. IBM 3600 Finance Communication System

The IBM 3600 Finance Communication System is a modular system consisting of IBM's current financial transaction terminals and communications controllers configured around a central host computer in the standard IBM network environment called Systems Network Architecture (SNA). The SNA concept is oriented to <u>centralized storage and processing</u> of information on one large host computer; in the 3600 System, the IBM 370 is utilized as the central host computer. Financial terminals, either in the same location as the central host processor, or in geographically remote branches or other locations, transmit data to the host for processing. Groups of terminals in various locations (a branch, for example), are linked by cable on unidirectional communications 'loops'. These terminal loops are connected to a programmable communications controller (IBM 3601 or 3602 Finance Communication Controller) which collects data from the terminals on a continuous basis. In addition to controlling data transmission from the terminals to the central computer, and to the terminals on return, the controllers can be programmed to direct the functions of attached terminals. The communications controllers are connected via common carrier telecommunication lines to an IBM 3704 or 3705 Communications Controller which mediates data communications to and from the host computer.

All files are maintained and updated in the central host.

The communications processors have some storage capacity, however, and can store a limited amount of transaction data; they can also be programmed to perform some processing and look-up functions. Controllers can therefore operate in an "offhost mode", i.e., not in communication with the host computer, without interruption in customer service. This allows controllers servicing various branches in the system to be kept in an offhost mode during peak periods, and transaction information to be relayed to the central files during less busy periods.

The 3600 System is designed to allow financial institutions to select from IBM's range of financial terminals the devices best suited to both their internal record keeping and customer transaction requirements, and to configure a network system in a flexible manner. The terminals available in the 3600 System include teller operated terminals (IBM 3604 Keyboard Display); a self-service customer operated terminal (3614 Consumer Transaction Facility); a point-of-sale terminal (3604 Financial Services Terminal or 3608 Priniting Financial Services Terminal); several types of document and passbook printers which can be used in conjunction with the teller terminals or independently (3610 Document Printer, 3611 Passbook Printer, 3612 Passbook and Document Printer); and a stand alone printer terminal used for administrative rather than customer transaction purposes (3618 Administrative Line Printer).

'Protocol' or 'line discipline', which determines the mode in which data is carried over communications lines, is an integral part of the network architecture. IBM's System's Network Architecture employs a protocol known as Synchronous Data Link Control (SDLC).[14]

The Canada Trust Co. is presently using an older line of IBM terminal equipment, and over the next few years will introduce the

3600 System in stages. Ninety-three of Canada Trust's 137 branches are presently on-line to the Company's central computer in London, Ontario, and by 1979 it is planned to have all branches integrated into a national on-line system using the 3600 System. Seven branches in Vancouver, for example, will connect their twenty-one terminals to communications controllers in Vancouver, and communicate with the central computer in London over a high-speed communication line leased from a common carrier. Canada Trust will use the 3600 System to service over-the-counter customer transactions in branches, and for the clearing of cheques within their central files once cheques have been returned to branches from the clearing system. While at this time Canada Trust does not plan on employing either the 3614 customer operated terminal or the 3606 point-of-sale terminal, the 3600 System allows such advances in EFT to be achieved in stages.

2. Tellshare

In contrast to the 3600 System described above, Tellshare is a distributed processing network developed in Canada by TRW Data Systems specifically for the Canadian financial community. Distributed processing networking is a relatively recent technology which decentralizes data storage and processing throughout a network. TRW's rationale in developing Tellshare was described as follows: "Canada is an immense country and the size creates data processing problems for those firms in the financial community with branches from coast-to-coast. Among the problems are communications costs to a central processor and transaction turnaround times... Tellshare increases the teller's ability to respond more quickly in today's competitive environment since the computer is likely to be resident at the branch location where the teller works."

In the Tellshare System all branch information (customer data, teller transactions) is stored on a TRW/Datapoint minicomputer in the branch location. Datapoint teller terminals, line printers, and other devices are connected to the minicomputer and both teller access to customer account information in an inquiry/response situation, and the updating of files when a transaction is effected, is

localized and immediate. A high-speed line printer is located in each branch and can access branch files and produce up-to-date customer statements and non-passbook transaction vouchers "on demand". Management reports and teller logs can also be produced by each branch. Each node of the distributed network is autonomous and can therefore be customized to the requirements of the particular branch.

In a distributed network, day-to-day branch operations are not vulnerable to failures on the part of a central computer, or telecommunication line failures. Therefore, reliability at the branch level is increased. Branch processors are connected to head office central computers, but all communications with the central computers can be done in batch mode once a day (transmission can be done during the night to save on transmission costs). Daily branch transaction information is sent to head office computers in summary form.

The Tellshare system provides for the inteconnection of branches; the Datapoint mincomputers can be linked to each other as well as to the central computer. This capability allows for efficient real-time inter-branch service such as the validation of customer accounts maintained in other branches, and inter-branch transfer of funds.

Metropolitan Trust Company in Toronto has installed the Tellshare system, plans to have all its Toronto branches on-line by the end of 1977, and then to intregrate its branches across the country into the network. Using the Tellshare system, the company plans to support total inter-branch service so that customers can conduct all transactions at any branch in the network, whether or not an account is maintained at the branch.[15]

NCR, a major supplier of financial computer equipment, is committed to the distributed networking approach. NCR recent announced

its Distributed Network Architecture (NCR/DNA) which is intended to be used with "distributed processing systems, including those providing electronic funds transfer". NCR's first product operating under NCR/DNA is to be a point-of-sale terminal, and other terminals in its product line will be integrated into this networking concept.[16]

The relative merit of decentralized and centralized processing for EFT is currently the subject of debate. Factors such as volatile communications and hardware costs, and changing payment techniques make long-term planning in this regard difficult. System security is a vital consideration since decentralization of control over machine-readable customer records goes hand in hand with the implementation of distributed processing systems.

B. Terminals

The availability of a range of specialized terminals for the financial industry represents perhaps the most significant technological capability which has contributed to the automation of the banking industry, and to evolving EFT systems. In general, terminals are devices which enable convenient data input/output in locations remote to the data processing unit. Computer hardware suppliers, particularly NCR, IBM, Phillips, Burroughs, Bunker Ramo and TRW, have developed and are continuing to refine specialized terminal products to support three major components of EFT: 1. teller operated terminals to support on-line branch and inter-bank banking (teller terminals); 2. self-service teller machines which enable bank customers to complete financial transactions without teller assistance either in a branch location or other locations where potential customer traffic is high (Automated Teller Machines or ATM); 3. terminals which take the place of manual cash registers at retail establishments and enable the direct transfer of funds from the customer's account to the retailer's account (Point-of-Sale or POS terminals).

1. Teller Terminals

The development of intelligent terminals and minicomputers has had a profound effect upon the capabilities of the financial industry to effect reliable and efficient on-line systems. Intelligent terminals have the ability to store data on a storage device, and to perform various editing and formatting functions prior to the transmission of data to the central computer. This capability not only increases efficiency in the utilization of communication links by allowing some preprocessing of data, but also reduces the dependence of the terminal on the central computer making on-line customer service more reliable. Applications such as the processing of withdrawal and deposit transactions were among the first to use terminals capable of performing simple arithmetic functions and accumulating totals, so that a passbook could be updated even when communication to the computer was not possible. Transaction information can be stored, while the updating of central computer files is effected in an automatic mode at a later time.

The emergence of minicomputers has greatly extended terminal capability independent of a central computer. Minicomputers, capable of a high level of data processing, and available at diminishing costs, can be used as intelligent terminals themselves or to control a number of other terminals. The IBM 3604 teller terminals operate under the control of a minicomputer, as described earlier, on which software can be programmed to support a large variety of on-line functions. Burroughs TC700 series teller terminals are examples of intelligent terminals which contain their own logic and memory, and can be programmed to perform arithmetic, checking, data formatting and data capture (total accumulating) functions. The Banque Canadienne Nationale currently has 300 Burroughs terminals in its on-line system, and attributes the early development of this on-line banking system to the introduction of these machines.

State-of-the-art teller terminals are highly specialized devices with many display and keyboard options which enable a financial institution to customize its terminals to its particular input and output requirements. Special function keys allow complex operations to be effected in a simple manner by the teller.

Teller terminals are now being produced with magnetic strip readers and encoders that can take customer and account identification information directly from plastic banking cards. These devices can also be used to magnetically encode documents, such as passbooks. This allows subsequent direct input through strip readers.[17]

2. Automated Teller Machines (ATM)

ATM terminals are devices which enable a full range of banking transactions to be completed by customers on a self-serve basis; single function cash dispensing units are precursors of ATM. Customers are guided step by step through their transactions by sets of instructions displayed on a screen. ATM's are activated by the insertion of a plastic card containing magnetically encoded identification information; to enhance security on such machines an additional personal identification number (PIN) is supplied to card holders by their institution, and must be keyed in by the customer. The PIN is checked against stored data when the transaction is relayed to the computer containing customer files.

ATM's can be programmed to support a large variety of transactions. The IBM 3614 Consumer Transaction Facility, for example, can handle account inquiries, deposits, transfer of funds from one account to another, and bill payments. Cash can be dispensed for withdrawals on up to four types of accounts, and cheques drawn against accounts in other financial institutes can be cashed. Optional receipts will be printed for the customer for various transactions. The range of transactions to be offered is, of course, determined by the financial institution itself.

The development of software to support on-line ATM's such as the 3614 requires a high programming investment on the part of the institution, and it is this cost that presents an inhibiting factor to the growth of ATM installations. IBM's data processing service arm supports remote 3614 systems for financial institutions, but because central customer information files are located in the institution's own computer, data must be transmitted back and forth between the IBM service bureau computer and the central files, rendering on-line processing inefficient.

Several chartered banks are using the 3614 on an experimental basis, in an on-line mode using IBM services, or in off-line modes. The Canadian Imperial Bank of Commerce has 87 CHUBB cash dispensers installed nation-wide and operated in an off-line mode. Several Canadian banks are employing the Docutel Total Teller 300 series mainly for cash dispensing in an off-line mode. Very few Canadian financial institutions have as yet developed their own software to support on-line ATM service. The Saskatchewan Credit Union in Regina is a known exception and supports a number of transactions in an on-line mode.

NCR Corp. recently announced a microprocessor based ATM: groups of these 1770 terminals can be linked to a single microcomputer which contains the software to run the ATM's and also links them to a central computer for on-line processing. The 1770 is among the first financial transaction equipment to utilize microprocessor technology. It is expected that further trends in this direction will enable the production of equipment such as ATM's at much lower costs. Prices for the 1770's now range from $13,000 to $15,000, and the microcomputer unit which controls up to eight terminals begins at $11,170, compared with an average "full-function" IBM 3614 which costs from $35,000 to $37,000. NCR's 1770 ATM is expected to be on the market by the end of 1977.[18]

3. Point-of-Sale Terminals (POS)

The concept of EFT has prompted the development of terminals which can support the direct transfer of funds from a customer's bank account to a retailer's bank account, initiated at the point of purchase. POS terminals for direct funds transfer are designed to initiate a transaction, through the insertion of magnetically encoded cards containing customer account identifying information, and to support a variety of on-line transactions. The Bunker Ramo Financial Transaction Terminal (FTT) provides capabilities for either checkout or courtesy counters including on-line cheque verification, credit/debit card authorization, transfers to and from checking, savings and bank-card accounts, and payments to card accounts, utilities and loans.[19] The IBM 3606 Financial Services Terminal has similar capabilities.

POS terminals are merely the initiating points of extremely complex organizational and technological systems which are largely in a conceptual phase. POS systems to effect direct funds transfer require the development of standardized debit cards, credit authorization schemes and a high degree of co-ordination among bankers and between bankers and retailers. Since retailers cannot realistically restrict the financial institutions with whom their customers may deal, point-of-sale systems require the interconnection of many computer system endpoints operated by financial institutions. This presupposes the availability of large-scale economical data communications networks with standardized interface procedures and complex message-switching systems able to route debit/credit transactions to the appropriate computer endpoint. Standardization of transaction message content and format is also required to enable the efficient processing of information by the various computer systems involved in a point-of-sale transfer. While there are a large number of POS terminals installed in retail locations in the United States, a very high proportion of these terminals are used for cheque verification purposes only. Cheque verification is a much simpler application to effect since it involves access to one computer system only. In Canada, the limited number of POS terminals installed are as yet used solely by large retailers, and only to capture sales data for automated sales and inventory record-keeping.

C. Software, Service Bureaus, Customer Information Files

Financial institutions initially utilized the services of computer service bureaus to support the data processing requirements of their on-line systems. There is an increasing trend, particularly on the part of larger financial institutions to develop and support their systems on an in-house basis, but software development costs are very high. A number of financial application software packages are available for purchase through computer manufactures. COFIS, for example, a software package which supports on-line savings, is available from IBM for the 3600 terminal system, and will be utilized by Canada Trust. Software for the support of new EFT equipment such as automated teller machines is not generally for sale, ATM's are as yet largely supported through equipment manufacturer service bureaus. As discussed earlier, many smaller financial institutions still utilize computer service bureaus for data processing services and maintain their files in these centres.

Another potential trend which can be isolated in relation to software support for EFT, is the widespread use of specialized systems developed by service bureaus or financial institutions to handle particular financial applications. Approximately thirty financial institutions in Canada, including most of the major banks, are using the services of MFS Limited, a subsidiary of the Multiple Access Computer Group, for the administration and processing of tax shelter plans such as RRSP and RHOSP. MFS maintains all plan-holder records for its clients, and has developed specialized processing software. MRS accepts and transfers contribution funds and mails cheques and receipts directly to plan-holders. MRS plans to implement an on-line system to enable its clients to enter plan-holder transaction data from their own institutions directly to the MRS host computer.[20]

Given the high cost of software development, service bureaus can be expected to continue to play a substantial role in developing EFT systems. Standards for security and privacy of computerized financial information required of financial institutions must equally apply to service bureaus.

Current data base management techniques provide a means of integrating a variety of data within complex Data Base Management Systems (DBMS). DBM techniques allow data to be stored in consolidated systems that can simultaneously support easy access and file modification by many data processing applications.

Machine-readable records containing customer financial information are of course integral parts of automated banking systems. While in the past these records were maintained as discrete files supporting individual applications (e.g. savings), financial institutions are increasingly employing DBMS techniques to build 'Customer Information Files' (CIF), which integrate all information on customers (all accounts, loans, etc.). As the range of automated functions increase and as EFT concepts are further implemented, the amount of customer information stored in CIF's will also increase. For example, Canadian banks are presently contemplating the consolidation of credit card information with other customer information.[21]

Control over the integrity, security and confidentiality of customer information is made more difficult by the consolidation of information in Customer Information Files. Systems which simplify authorized access to and modification of information are also more vulnerable to misuse and unauthorized access.

Current concerns regarding the security and privacy of personal information held in computerized data banks are compounded in financial systems. While indiscriminate disclosure is as much a problem, the need for security in financial systems is increasing be-

cause of the potential for embezzlement. At a recent conference on data security, a speaker representing a data processing firm serving 31 American banks, reported that the implementation of CIF had exposed the company to unanticipated security problems.[22]

The trend toward distributed processing and the decentralization of files into branches, will require stringent security measures to be implemented at these locations as well as in central processing centres.

In considering the evolution of EFT to a stage where many data processing systems will interact through the transfer of data, it is important to realize the limitations of applications software. Programs are sets of instructions specified to the finest detail, and the processing of data is enabled via detailed data format specifications. The encoding practices and formats now in use by the various intra-bank systems must be standardized to make large-scale interaction practical. In the absence of standardized formats, data has to be converted to the local standard of the receiving institution, then entered into the system for subsequent processing by application software. While a central clearing system could undertake conversion of the multiplicity of formats in use by participating organizations, software development costs would become prohibitive as the number of endpoints in the system grew. Whereas the cost of hardware continues to decline, the production of software involves very high and rising labour costs. Agreement on standard formats for transactions flowing between potential participating sectors will constitute an essential first step towards further EFT development.

IV. DATA COMMUNICATIONS IN CANADA AND EFT

1. EFT Data Communications Requirements and Packet Switching

Data communications involves the transmission of data from one location to another; a data communications network consists of a set of nodes connected by a set of links. Nodes in a network may be

terminals, computers, or various types of communications control units and links are the communication channels which provide a path between the nodes. In a typical on-line banking communications network, bi-directional links must be established between various teller terminals in many branch locations and computers in central or regional data processing centres.

The earliest computer communications traffic was carried over telephone networks on point-to-point dedicated lines with circuits connecting each terminal to its host computer. Telephone communication circuits are not efficient carriers of computer data because they transmit signals in analog form while computers operate in a digital mode. Digital signals must therefore be converted to analog form prior to entry to the network, and converted back to digital form at the destination. Telephone networks require the physical switching of circuits in non-point-to-point situations, and call set-up times are relatively long compared to the length of time actually needed to transmit a short message. Therefore, they are inappropriate for real-time inquiry/response transactions where response time is critical.

In 1973 Trans-Canada Telephone System (TCTS) introduced the first national digital network in the world, called Data-route. Shortly thereafter Canadian National/Canadian Pacific Telecommunications (CN/CP) introduced Infodat. These two national trunk systems represented a major advance in date communications capability in Canada. Digital networks provide a much higher degree of accuracy and efficiency for data transmission than do analog networks.

Both Dataroute and Infodat provide dedicated point-to-point digital service. This means that the user is charged for rental of the circuits on a continuous basis. While dedicated lines ensure fast response, they are only cost-effective when the volume of data to be transmitted is very high. Multi-point and multi-drop networks allow multiple terminals to utilize the same dedicated lines. This reduces the number of dedicated lines required, but there is a signifi-

cant burden placed upon the host computer since only one terminal may transmit at any given time, and control programs are required to monitor and organize data flow. Many financial institutions now utilize either Dataroute or Infodat for their on-line systems. The need for many dedicated point-to-point links to connect dispersed branches and ATM equipment, is an inhibiting cost factor in the implementation of EFT applications.

Another type of data communications system being utilized by Canadian financial institutions was introduced in Canada in the late 1960's by both CN/CP (Telenet) and TCTS (Message Switching Data Service). These are store and forward message switching systems which utilize computers at intermediate points in the network to route messages received from the source to the destination. This allows sharing of the network, unlike the point-to-point dedicated circuits of Dataroute and Infodat. CN/CP dominates this market and the five largest chartered banks utilize Telenet for the transmission of batched data and administrative messages. While the reduced costs of these store and forward message switching systems can be realized by financial institutions for the transmission of data of this type, response time does not meet the requirements of on-line banking.[23]

Fully realized EFT systems are dependent upon the cost/effective interaction of terminals and computers operated by many institutions, including credit bureaus, trusts, retailers and banks via comprehensive data communications facilities. Interconnection of the many private networks which have been developed presents a host of technical difficulties since each network often employs incompatiable computer systems and network protocols.

Protocols are defined as "a predetermined dialogue, scrupulously maintained by both ends of a communications data link."[24] There are many levels of network protocols, also called line disciplines or procedures. As discussed earlier, computer manufacturers are integrating

their computer and terminal equipment in standarized network architectures. To date the protocols used in these network architectures are not compatible, and interconnection between them is problematical.

The development of common user networks through the use of common network protocols presents one general solution to the problem of interconnecting heterogenous computers and terminals. Recently developed packet switching technology provides one means of implementing common user networks.

Although further innovation and refinements leading to greater effectiveness in packet switching technology can be expected, several large-scale packet networks in use for particular applications, such as airline reservation systems, have shown impressive operational results. ARPANET, the first packet switched network which was developed and implemented by the U.S. Defense Department, has demonstrated that such networks are well suited to the interconnection of diverse computers and terminals. ARPANET's reliability, response time and cost (cost per megabit is purported to be lower than any other method except magnetic tape transfer by mail) have been impressive enough to prompt the construction of public and private packet-switching networks on varying scales in many countries including France, Spain, Japan and Great Britain. A major packet-switching project is being developed through the co-operative efforts of the various Postal Telephone and Telegraph authorities in nine European Common Market countries.

Packet switching is a form of message switching which operates on the principle of <u>virtual</u> circuits. A logical, rather than a physical connection is made between the source and the destination. This is made possible by the disassembly of messages into standardized character 'packets' which are moved through the network in that form rather than as discrete characters. Each packet contains an address, a sequence number and checking/control information. The choice of a path through the network for each packet is determined dynamically by the local interface processor according to network activity, and packets are reassembled at the destination into the original message. Because this

technology enables the sharing of high speed digital channels, and response time is suitable for real-time inquiry/response applications it combines the best of earlier data communications technologies available in Canada.

In summary, packet switching presents the following advantages to applications such as EFT:[25]

1. Because a physical connection between source and destination is not affected in packet switched networks, and the network is shared, charges are based primarily on the volume of data transmitted rather than on connect time. This is of particular economic advantage to users whose messages are short, such as is the case in real-time inquiry/response financial transactons.
2. Network switching nodes can be programmed to perform many communications functions which otherwise must be performed by user equipment and add to user costs.
3. Response time is fast enough to support real-time applications, and because dynamic, alternate routing is employed along an optimum path, transmission is efficient even if one route is interrupted or congested.
4. Packet networks are flexible in their ability to accommodate new and innovative equipment and network structures and requirements. This flexibility is important to the success of systems such as EFT which are in a transitional, evolving state of development.
5. An error rate substantially lower than other methods of data communications is claimed - "accuracy is estimated to be in the region of one undetected packet error in 5×10^8 packets transmitted."

6. The critical characteristics of public packet-switching networks for applications such as EFT is that communication between many user systems is made possible in an efficient mode. In private networks, interaction between terminals and computers is restricted to the network and private networks are for the most part incompatible. Public packet-switching networks provide a solution to this problem.
7. Given the existence of a public national packet network, data communications users have the ability to implement a nationwide network with a great deal less capital investment and time delay than would be required to construct a private network.

2. X.25 Protocol

An international protocol for packet switching networks was adopted first in 1976 in the form of a recommended standard known as X.25 by the Consultative Committee on International Telephony and Telegraphy (CCITT), the international telecommunication carrier standards organization. The TCTS played a leading role in the development of X.25 which is very close to its Standard Network Access Protocol (SNAP) developed for Datapac, and along with the French PPT and the U.S. packet network telenet, took a strong role in effecting X.25's adoption by the CCITT; Canada is represented in the CCITT by the Department of Communications and the CTCA. Considerable controversy among carriers and between equipment manufacturers is taking place over X.25. Carriers such as CN/CP and the operators of France's Cyclades Network, while in favour of an international standard, consider the adoption of X.25 precipitate. These carriers maintain that there are as yet many deficiencies and unresolved technical problems, particularly relating to the ease and cost of connection on the part of users. Controversy between carriers and equipment suppliers has centred on who should specify the 'packet level' protocol which determines the mode in which equipment interfaces with the network and,

therefore, affects equipment marketing. "The carriers insisted that a standard protocol was needed so that different terminal and computer systems could communicate...suppliers and users...(emphasized) the need for a flexible standard or standards that would permit the user to optimize the performance of his existing hardware and software... the carriers wanted to control the packet level protocol so they could perform the related control functions within their own networks and/or be the major suppliers of packet assembly and disassembly equipment...the equipment manufacturers meanwhile, wanted to protect their markets against this competition."[26]

While several mainframers are developing packet network protocol, "none is fully compatible with X.25...Although X.25 interfaces have been promised, they are not likely to become available for at least a couple of years".[27] In the meantime, equipment connected to packet networks must connect via network interface machines (NIM) which effect the required conversions to X.25 format at both the input phase and output phase. The full economic advantages of packet-switching will not be realized until manufacturers meet user's need for equipment which can directly interface with the networks.

An alternative protocol to X.25, which is specifically aimed at increasing the efficiencies associated with X.25 for short messages such as point-of-sale and short financial transactions, is presently being undertaken by the American National Standards Institute (ANSI). ANSI expects to present its 'datagram' protocol to the CCITT by the spring of 1978 for incorporation into the X.25 standard. NCR, a principal supplier of EFT/POS systems, is purported to be strongly behind the datagram standard.

3. Datapac and Infoswitch

In 1974, the TCTS announced its intention to construct Banknet, a national data communications network for financial transactions. Response by the Canadian banking community to this announce-

ment was extremely unenthusiastic, and TCTS broadened and expanded its original conception of the network to the scope of Datapac, the multi-purpose public packet-switched network now being implemented.[28] While the TCTS now plans a much broader scope of user applications for Datapac, it considers that Datapac is "a major step in producing a universally compatible system for such transactions as electronic banking."[29]

Datapac's tariffs were approved June 15, 1977 by the CRTC and its is expected that it will be fully operational by the early 1980's. Initial customer trials began prior to tariff approval in January 1977. To date there are no users of Datapac within the financial community; the TCTS marketing divisions are presently working toward interesting the banks in Datapac services.[30]

Datapac Servicing Exchanges have been established in 57 Canadian communities; TCTS claims other locations can access the network via "off-network arrangement". As of August, 1977 Datapac was servicing "several hundred terminals" and approximately ten host CPU's were interconnected; these include IBM, DEC, Univac, Amdahl and Honeywell mainframes.[31]

Datapac now supports two basic services:

Datapac 3000: connects intelligent devices (computers communications processors; programmable terminals) at synchronous speeds up to 9600 b.p.s.

Datapac 3101: connects non-intelligent, asynchronous terminals to the network via Network Interface Machines (NIM's)

Intelligent devices accessing the network using Datapac 3000 must employ SNAP, TCTS's Standard Network Access Protocol, which as earlier described, is compatible with X.25, the CCITT approved protocol. Non-intelligent devices (the majority of on-line banking terminals now in <u>use</u> are of this variety, although as discussed elsewhere in this paper, intelligent banking terminals for a variety of applica-

tions are now very much in evidence on the market), interface with Datapac Network Interface Machines (NIM) which translate user data into the SNAP format.

Telenet, the nation-wide packet-switched network available since 1975 in the U.S., provides its services at a flat rate of 60¢ per 1,000 packets (kilopacket). The TCTS has made an agreement with Telenet Communications Corp. to provide U.S. users access to Datapac and Canadian users access to Telenet for various applications. An EDP In-Depth Report states that when TCTS began to handle Telenet services in Canada, Canadian customers who had formerly used Telenet directly and were charged the standard rate found that their costs tripled to $1.95 per kilopacket.[32] The Evans Consultants predicted in the report that packet switched services were not likely to be flat-rated across Canada given the difficulties of Canadian geography. This has in fact proved to be the case as the charge structure below indicates:[33]

NETWORK RATE EXAMPLES

The following is a nine city rate matrix for Datapac transport network (between or within Datapac Serving Exchanges) service. It is taken from the 53 city matrix as filed with the CRTC for regulatory consideration. Costs are expressed as $/kilopac

Priority service bears a 25% premium on the standard rate and packets are limited to a maximum of 128 characters each.

Vancouver	0.19								
Calgary	0.53	0.19							
Regina	0.74	0.54	0.23						
Winnipeg	0.84	0.71	0.50	0.23					
Toronto	0.93	0.89	0.84	0.77	0.15				
Montreal	0.95	0.91	0.88	0.82	0.40	0.15			
Moncton	1.56	1.52	1.50	1.47	1.20	1.02	1.31		
Halifax	1.04	1.00	0.97	0.94	0.70	0.58	0.87	0.23	
St. John's	1.07	1.03	1.01	0.98	0.85	0.79	1.23	0.65	0.23
	Van	Cal	Reg	Wpg	Tor	Mtl	Mct	Hfx	St. John's

***SYSTEMS COMPARISONS - DATAPAC VS NON-DATAPAC**

System	Application	Location	Terminals	Volume	Datapac	Non-Datapac	Difference
1	Warehouse Inventory Control	8 cities across Canada	Computer with SNAP + 19 CRTs with SNAP	733 Kilopacs per month & closed user group	$2,250	$7,280	−69%
2	File access to central computer	9 cities from Regina to Quebec	Computer with SNAP + 13 VUcom 3 CRTs	291 Kilopacs per month	$1,140	$2,775	−59%
3	Inventory Control and Order Processing	13 cities across Canada	Computer with SNAP + 24 Datacom 400 Teleprinters	1100 Kilopacs per month	$3,575	$6,040	−41%
4	Credit Authorization, Data Entry, Inquiry Transactions	Mtrl, Toro, Vanc	Computer with SNAP + 2 intelligent terminals with SNAP	1250 Kilopacs per month + closed user group	$6,500	$10,000	−35%
5	Inquiry/Response in Financial Institution	7 cities in Ontario	Computer with SNAP and 6 financial controllers with SNAP	175 Kilopacs per month	$2,500	$3,000	−17%

*These comparisons are based on studies of existing systems and compare the most economical non-Datapac situations with the most application-effective Datapac configuration. Where applicable, SNAP must be implemented in the user's equipment either by the user or the computer or terminal manufacturer.

While intra-city and short-haul customers are charged in many cases substantially less than the Telenet flat-rate of 60¢ per kilopacket, long-haul users, e.g., Vancouver to Toronto, are charged significantly more (93¢). Priority services, i.e., guarantee of immediate transmission, costs an additional 25% more than the standard rate. Users who must utilize Network Interface Machines are charged an additional 25¢/kilopacket. The cost for priority service from Vancouver to Toronto for a non-intelligent device would be $1.45/kilopacket.

The systems comparisons between Datapac and non-Datapac situations above show Datapac to afford significant savings, but for many data communications users in Canada, Datapac's tariffs will not be competitive with U.S. rates. This situation will compound the existing situation of "transnational data flow"; the Federal Department of Communications estimates that lost revenues of $150 million to $300 million have resulted from the processing of Canadian data outside the country.[34] In March 1978, TCTS filed rates with the CRTC for the interconnection of Datapac with two American packet networks, Tymnet Inc. and Telenet Communications Corp. Canadian computer/communications users will have access to over one hundred cities in the United States through the interconnection of Datapac with these two networks.[35]

As of November 1977, CN/CP had established 56 servicing areas for its Infoswitch network. Infoswitch combines three types of services:

Info exchange: provides dedicated digital service on a 'charter' basis. It is a circuit switching network which provides use of circuits for the length of time required, and is meant to be used for the transmission of batched data.

Infogram: provides packet-switching service for intelligent terminals and computers which have implemented the network packet protocol.

Infocall: provides packet-switching service via network interface equipment, for non-intelligent devices or for devices which have not implemented the packet protocol.

CN/CP supports the concept of an international standard for network interfacing, but considers that X.25 in its present form is not sufficiently well defined to allow successful implementation. Approximately fifty aspects of X.25 are as yet being studied by the CCITT, and CN/CP plans to adopt X.25 in its finalized form following the study period 1977 to 1981.[36]

4. Data Communications: Regulation and Competition

The following discussion describes the regulatory framework within which data communications services are supplied in Canada, the effect of interconnection regulation on competition between the two major carriers, and perceived impact of present regulation on computer/communications applications such as EFT.

While there are hundreds of telecommunication carriers in Canada, the bulk of telecommunications services is provided by the major regional telephone systems which have a monopoly on telephone service. These carriers, along with the railway consortium CN/CP, Telesat Canada, and Teleglobe Canada, are associated within the Canadian Telecommunications Carriers Association (CTCA) which consists of the following companies:

(1)	(2)
Newfoundland Telephone Co. Ltd.	Canadian National Telecommunications
Maritime Telegraph & Telephone Co.	Canadian Pacific Telecommunications
New Brunswick Telephone Co. Ltd.	Quebec Telephone
Manitoba Telephone Systems	Northern Telephone Ltd.
Saskatchewan Telecommunications	Ontario Northland Telecommunications
Alberta Government Telephones	Edmonton Telephones
British Columbia Telephone Co.	Teleglobe Canada
Bell Canada	Canadian Independent Telephone Assoc.
Island Telephone Co.	Telebec Ltée.
Telesat Canada (See footnote 37)	Telephone du Nord du Quebec Inc.
	Trans-Canada Telephone System
	Okanagan Telephone Co.

The ten companies in Column 1 are members of the Trans-Canada Telephone System (TCTS),[37] an association organized to co-ordinate national telephone service. Under the CRTC Act, Bell Canada, B.C. Telephone, CN/CP, and Telesat Canada, a Canadian corporation created in 1969 to establish and maintain domestic satellite communication, are regulated by the CRTC. Teleglobe Canada, which provides overseas telecommunication links, reports to the federal Minister of Communications, rather than to a regulatory agency. The remaining carriers are regulated within provincial jurisdictions by utility boards. The exception is Saskatchewan Telephone which reports to the provincial Minister of Communications. Major carrier companies affiliation, ownership, regulation, total plant at cost, total operating revenue are listed below in Table 1:[38]

TABLE 1

CHARACTERISTICS OF MAJOR CANADIAN TELECOMMUNICATIONS CARRIERS FOR 1975*
(in thousands of dollars)

Company	Affiliations	Ownership	Regulation	Total Plant at Cost	Total Operating Revenue
Bell Canada	CTCA, TCTS	private	federal	$6,360,539	$1,665,870
British Columbia Telephone Co.	CTCA, TCTS	private	federal	1,473,731	360,687
Alberta Government Telephones	CTCA, TCTS	public	provincial	1,101,687	239,788
CN/CPT	CTCA	private/ public	federal	583,749	171,949
Manitoba Telephone System	CTCA, TCTS	public	provincial	430,648	91,274
Saskatchewan Telephones	CTCA, TCTS	public	provincial**	388,737	92,103
Maritime Tel. & Tel. Co. Ltd.	CTCA, TCTS	private	provincial	372,591	90,621
New Brunswick Tel. Co. Ltd.	CTCA, TCTS	private	provincial	296,665	76,451
Teleglobe Canada	CTCA	public	federal***	196,840	59,660
Newfoundland Telephone Co. Ltd.	CTCA, TCTS	private	provincial	169,423	43,093
Telesat	CTCA	private/	federal***	136,609	31,129

*Ranked in order of size.
**Saskatchewan Tel. reports to the provincial Minister of Communications, rather than a regulatory agency.
***Teleglobe and Telesat report to the federal Minister of Communications, rather than a regulatory agency.
Source: Financial Statistics on Canada Telecommunication Common Carriers, 1975.

The telecommunication common carriers in Canada are the major carriers of data communications. Data communications undertakings are regulated within the overall jurisdictional and regulatory framework governing telecommunications outlined above. While regulation over the provision of data communication services is exercised, it is accomplished in an indirect fashion. Regulations which apply to the telephone network systems by default apply to data communications. Rapid advances in data communications technology have rendered present regulations obsolete. Carrier policies, enabled under regulations conceived to govern telephone system monopolies, inhibit competition in data communications services.

Only one (Ontario Telephone Service Commission) of the 10 agencies responsible for the regulation of telecommunications is solely concerned with communications matters; often "no specific reference to telecommunications as such is made in the enabling statutes, beyond the inclusion of such service within the general definition of public utility."[39] The Computer/ Communications Task Force suggests there has been a response to unique conditions and problems

associated with computer/communications but that: "The lack of a co-ordinated authority over the tariffs and conditions for international and interprovincial data traffic, and over the uses to which customers may put such links, is one of the more pressing jurisdictional issues relating to computer/communications in Canada."[40]

Two important issues require policy reformulation directly in relation to computer/communications as distinct from other forms of telecommunications:

1) Foreign Attachments: This issue concerns the extent to which customers are permitted to attach non-carrier provided devices directly to carrier networks. Traditionally, common carriers have severely restricted or altogether prohibited foreign attachments for such reasons as the threat to system integrity, problems attending divided responsibility for system maintenance and operation, etc. The C/C Task Force determined that, at the federal level, "foreign attachment policy is ill-defined and in most cases, ineffective... At the provincial level...no provincial agency in Canada has the power to require foreign attachments to be connected to the utilities under its jurisdiction".[41] The first phase of a program for the certification of computer equipment to be attached to carrier networks was initiated by the government in 1976, but the program applies only to federally regulated carriers.[42]
2) Interconnection: The interconnection issue concerns determination as to interconnection between carriers' networks and between carrier networks and private networks. While many of the statutes provide for regulation as to the interconnection of various

utilities, neither federal nor provincial regulatory bodies have the power to order interconnection between carriers and private communication systems.[43] The interconnection issue presently affects competition between the two major data communications carrier and is discussed below.

The Telecommunications Act (Bill C-43) which had first reading in March 1977, frames new federal policies and procedures relating to telecommunications with the intent of ensuring the continued development of efficient telecommunications in Canada.[44] It would appear to broaden and consolidate regulatory powers over federally regulated carriers. Under the Act, the CRTC is empowered to direct "a telecommunication carrier to permit the interconnection of its facilities with other facilities or equipment on such terms as the Executive Committee may determine" (Section 55 (f)) and to direct "a telecommunication carrier to permit the attachment to its facilties of other facilities on such terms and conditions as the Executive Committee may determine" (Section 55(g)). Section 56 empowers the CRTC to prohibit new carrier entry to the telecommunication field and to restrict the undertaking of major extensions on the part of existing carriers. Public hearings are not required for decisions to be rendered on matters covered by the above sections; sections 55 and 56 are subject only to section 27 (2) where in the Commission may hold a public hearing if it considers it "in public interest" to do so.

Bill C-43 has met with strong opposition by Canadian telecommunications carriers as represented by the CTCA. As indicated by a CTCA statement, the carriers perceive the increase in government control over telecommunications as it is articulated in the proposed legislation as "symptomatic of a general trend by governments and regulators to move from their respective roles as policymakers and arbiters of the public interest into the actual management of telecommunications carriers".[45] The CTCA year-end

report for 1977 stresses the importance of Bill C-43 to the industry, and calls for rationalization of control in a manner such that both the public interest and the viability of the industry will be served. Among the CTCA's proposed amendments to the bill are "a clear right to appeal all regulatory decisions, and mandatory public hearings before decisions are rendered on any matter affecting the basic structure of the industry."[46]

The principal carriers of data communications are the TCTS and CN/CP, each of which provide long-haul data communications services on a nationwide competitive basis. In its Annual Report for 1976-1977, the CRTC reported that the data communications market is presently split about evenly between the two carriers.[47] However, TCTS's monopoly over local telephone loops provides them with a major competitive advantage in the development of computer communications networks; CN/CP must negotiate for the right of access to the public telephone switched network, and to date there has been "minimal" interconnection between the two systems.[48] A recent market study by CN/CP revealed that its share of the Canadian computer/communications data market is less than 9%. CN/CP attributes this low share of the market to its inability to interconnect with public switched telephone facilities.[49] In June of 1976, Canadian Pacific filed an application to the CRTC for interconnection rights to Bell Canada's telegraph and telephone system, requiring Bell Canada "to afford all reasonable and proper facilities for receiving, forwarding and delivery of telegraphic and telephonic messages...upon and from its telegraph and telephone system or lines', for the interchange of telecommunications traffic, and for the connection of their respective telephone systems."[50] Hearings on this application began March,1978. The CRTC's decision on this application will greatly influence the growth of universal public data networks in Canada, the options of data communications users to choose between more than one carrier in any particular location, and the ultimate reliability of large-scale data communications applications. Choice between CN/CP and TCTS services is now weighted heavily on the side of TCTS. Remote dial-up users who inter-connect to data communica-

tions systems via Bell lines are prevented from using CN/CP systems because the latter cannot, by present interconnection policy, be interconnected to Bell lines. This means that only users who have sufficient volume to warrant the high cost of dedicated lines, who are in a point-to-point situation, or who dial-up via CN/CP local loops have the option of employing CN/CP data communication services.

Submissions to the CRTC from data communications users, in support of CN/CP's application and discussions among data communications specialists, focus on the following key concerns regarding the resolution of the interconnection application:

1. To ensure maximum reliability of transmissions many data communications users employ parallel CN/CP and Bell systems so that in the event of equipment failure on the part of one carrier, immediate back-up is available via the alternative carrier. Multiple Access Computer Group, a service bureau which serves a national network of users, states that the majority of its users cannot avail themselves of this facility since they are remote Bell dial-up users.[51] The need to employ dedicated lines in order to be availed of adequate back-up facilities is a major factor inhibiting users from developing cost-effective computer/communications networks in Canada.
2. Flexible data communications facilities are critical to evolving applications such as EFT. There is concern that the present situation will limit user options and thus reduce the benefits to be derived from new technologies such as the packet switching networks now available from the two major carriers. While features and services unique to each of the packet networks may warrant use of both, the majority of users, i.e., those who employ Bell dial-up facilities, will be restricted to using the TCTS network only.

3. The need for cost-effective data communications facilities in all parts of the country, including remote areas, is obviously a critical parameter affecting widespread computer/communications development such as large-scale EFT. As discussed, the necessity for dedicated lines for maximum reliability unnecessarily increases costs. In addition, there is widespread feeling that only in a truly competitive environment will carrier tariffs be competitive with U.S. rates.
The ability of CN/CP to compete on an equitable basis will promote not only competitive rates, but also technological innovation and a high level of system maintenance on the part of competing carriers. A competitive environment, such as now exists in the U.S., will promote the development of specialized carriers to service special applications. In the U.S., 'value-added' carriers are permitted to utilize common carrier lines to provide data communications services. American 'value-added' networks such as Telenet have built large networks in very short periods of time, and have introduced technological advances at impressive rates.

The submission of the Bank of Nova Scotia in support of CN/CP is representative of the concerns of financial institutions, the majority of whom are looking ahead to increasing utilization of data communications services over the next decade. The Bank's submission addresses the issues discussed above in relation to its own data communications applications and also addresses the viability of an integrated electronic payment system within Canada. Nova Scotia presently operates two national computer/communications networks, one which supports centralized data processing services via nine regional data centres hooked into a centralized data processing centre in

Toronto, and one which supports its on-line banking terminal communications which presently consists of approximately 700 branches. For both of these applications, branches and customers are extremely reliant upon timely processing and a very high level of reliability. Nova Scotia is in the process of extending the scope of its on-line transactions to include demand deposit accounts and loans; it considers the viability of such a move to be highly contingent upon the availability of communications back-up facilities at a reasonable cost. In its interconnection to the international payments system network SWIFT (Society for Worldwide International Financial Transactions), the Bank is restricted from utilizing CN/CP back-up facilities because of TCTS restrictions on interconnection. The Bank is also particularly concerned that the future development of a Canadian integrated payment networks may suffer because of a lack of real competition between carriers. Should present policies persist, financial institutions will have no real choice between the two public data switched networks.[52]

V. SWIFT INTERNATIONAL PAYMENTS NETWORK

The international payments network developed by the Society For Worldwide Interbank Financial Communication (SWIFT) provides a model for inter-bank co-operation in the development of electronic funds transfer systems. Agreement as to the standardization of payment messages (content and format), rigorous selection of network hardware, specialized software development, and the integration of security measures have resulted in a system which is customized to the electronic exchange of international payments transactions.

SWIFT was chartered in 1973 through the association of some 240 European and North American banks, and as of November 1977, membership had expanded to include over 500 banks in 17 countries. Canadian membership included seven of the chartered banks as of

January 1977: Bank of Montreal, Bank of Nova Scotia, Banque Canadienne Nationale, Canadian Imperial Bank of Commerce, Provincial Bank of Canada, the Royal Bank and the Toronto-Dominion Bank. Canadian participation is co-ordinated through the Canadian Bankers Association.

Operational use of the network had commenced by the summer of 1977 and by September 1977 the first phase of operational implementation in a total of 15 countries, including Canada and the U.S., was commenced; Japanese member banks are expected to begin accessing the network in 1979. SWIFT is now handling approximately 40,000 messages a day, and anticipates an average of over 300,000 per day at a fully operational level. SWIFT is intended strictly for international transactions; all messages must be destined to points outside the country of origin.[53]

Prior to the implementation of SWIFT, despite various levels of financial network development in various countries, the majority of international transfers were effected by mail or telex. SWIFT's goals are to increase the speed of transfers, and to enable banks to send and receive payments in machine-readable form with the specific objective of facilitating the automation of international payments departments.

The first step towards meeting these objectives was agreement as to standard message formats to allow interbank exchange of messages. To date SWIFT has standardized message formats for customer transfers, bank transfers, foreign exchange including loan and deposit transactions, and reconciliation messages such as statements and confirmations: "The system offers the first international standard at the transaction processing level in international banking ...the larger international department...can automate significant proportions of both the transaction processing function and the downstream control and accounting entries resulting thereform."[54]

The SWIFT data communications network consists of two message switching installations, one in Amsterdam and one in Brussels. The switching centres are connected via high-speed telecommunications lines to 'national concentrators' in each of the participating countries. Each of the switching centres consists of two Burroughs B3700 computers, and each of these large computers used for message switching functions is equipped the two communications front-ends (B744) which link the computers to the network. Duplication of equipment in each of the switching centres is a standard measure known as 'redundancy' which ensures network reliability. Should one of a pair, or even both computers in one of the centres be out of operation, service can be maintained. Alternate, back-up telecommunication routes are also part of the network's reliability features. Canada's national concentrator, situated in Montreal, is normally connected to the switching centre in Brussels, but should that connection be faulty, or the Brussels centre be out of operation, Canadian traffic can be routed to the U.S. national concentrator in New York via an established back-up line, and from there to the switching centre in Amsterdam to which the U.S. centre is connected.

The national concentrators are Burroughs minicomputers which accept, store, and forward messages to the switching centres. In such a store and forward system, dedicated telecommunications lines are used between the concentrator and the message sending equipment. The concentrator continuously monitors all lines, accepts messages as they are transmitted by the sender, stores them, and forwards them as soon as a transmission path is available. The dedicated lines connecting the banks' terminals to the national concentrator are not SWIFT's responsibility; these must be leased from local carriers. In Canada, the majority of traffic at this stage will be from international departments in Montreal and Toronto to the concentrator in Montreal; it is the intention of the participating banks to connect only their international departments.[55]

Interface devices to connect bank terminals to the network must meet SWIFT specifications; to date three SWIFT Interface Devices (Sids) supplied by Burroughs, Singer and General Automation have been approved. Burroughs was also selected to develop much of the SWIFT software; a SWIFT representative worked as part of the dvelopment team at Burrough's Pennsylvania plant. It is claimed that in its determination to meet banking network requirements, SWIFT has set new precedents in its approach to network development: "SWIFT has achieved in the computer industry a new image, as an example of 'user power' in an environment accustomed to more lethargic styles".[56]

Security measures have been given high priority in the implementation of the SWIFT network because of the necessity to protect the integrity and privacy of financial information passing through the system. Access to the private network is strickly controlled by user and message identification measures, and SWIFT utilizes encryption methods throughout the network; i.e., between the concentrators and the central computers. Member banks must decide whether the encryption of information between their terminals and the national concentractors is cost justified. The control of transmission errors is also given high priority and effected by a standard series of checks. All information received by the central computers is stored on back-up devices (disk and magnetic tape) and kept for a set period of time so that reconciliation enquiries can be made through these log files.[57]

VI. CONSIDERATION OF A COMMON USER NETWORK

In 1975, the federal government published a policy paper on computer/communications and the electronic payments systems, in which it declared its support for a 'common user communications network':[58]

"This network is defined as a shared service which would be openly accessible to all qualified users on a fee-for-use basis. This recommendation would not preclude the use by individual institutions of private communciations systems for purposes that are entirely internal to the institution, and are unrelated to payment transactions."

While government objectives were directed toward the growth of an efficient electronic payments system and an "enhanced competitive environment" in the financial market, the fostering of "efficient and reliable nationwide systems of publicly-accessible data communications facilities" and the concomitant continuation of Canadian control over telecommunications facilities in this country was of equal concern. TCTS had, in the previous year, announced its intention to implement an innovative packet switching network which would support interaction between many users. CN/CP's announcement of Infoswitch followed shortly. Binhammer suggest that the policy paper "was precipitated in large part by the innovations that were already underway in the two major telecommunications groups".[59] In its position paper, the government did not point to any particular communications technology or network, but is clear that it sought to promote emerging EFT applications, and at the same time, to establish an initial user base for the forthcoming carrier offerings.

By definition, the common network precludes use of private communications systems for any purpose related to payments transactions. This means that a financial organization utilizing the IBM 3600 Financial Communication System, for example, would be required to adapt its system to the network, both for interface with other users on the network and for communications between its data processing centres and branches. At present this does not constitute an economical or efficient communications alternative for such users. It is expected that finalization of the X.25 protocol,

and the proliferation of packet-switching networks will result in the development of efficient computer system interfaces to packet networks by computer manufacturers. However, as one of the world leaders in implementing large-scale packet-switching networks, Canadian data communications will necessarily experience the difficulties inherent in a rapidly evolving computer/communications technology, and a concomitant instability in the market-place.

The interface problem concerning common user networks is likely to be short-term. The question as to whether the financial community will have a direct influence on performance criteria, reliability and security features, is a matter for concern where a common payments network utilizes an existing common user network. The SWIFT network described earlier was designed and implemented to meet the specific requirements of financial applications, and all components are under direct control of the Society, including the major switching nodes. While an 'Implementation Committee' consisting of financial institutions, computer manufacturers, common carriers and users was set up by the government to develop such standards and performance criteria for a Canadian payments network, it is uncertain to what extent the common carrier networks will be influenced by this body.

Another implication of a common user network to be considered is that of competition. Presently, Canadian financial institutions utilize the services of both major carriers, and as earlier discussed, the effects have been beneficial to users. There are in fact two networks with the capability of providing common user services. Indicators such as the government's support of Telesat Canada's merger with TCTS (see footnote 37), reinforce perceptions that Canadian government policy is inclined toward a monopolistic data communications environment. Were TCTS to provide the common payments network, CN/CP's ability to service the financial community would be strictly limited to non-payment transactions.

The common network as defined would also preclude specialized carriers from servicing the payments system. There is a growing number of American computer service organizations providing specialized carrier services to the EFT market. Other 'value-added' carriers, allowed to interconnect with American common carrier facilities, have developed innovative and large switching networks in short period of time. The competitive U.S. environment has also resulted in much lower rates for data communication services than here in Canada.

In 1971, the Science Council of Canada recommended the establishment of a national public computer communications network - Trans-Canada Computer Communications Network (TCCN). The TCCN would take the form of multiple sub-networks, each tailored to its environment but able to interface with the network and to communicate with other network users. The Council envisioned a digital, federally regulated 'National Spine' forming the basis of the TCCN: it considered that both packet switching (for short, real-time message traffic) and digital circuit switching (for bulk data transmission) should be available and that both TCTS and CN/CP would share in the provision of digital trunks. The Council considered a single monolithic network impractical.[60] The success of services provided by specialized carriers in the U.S., who would, in the Council's schema, have a legitimate role in supporting and tailoring private networks, lends credence to the National Spine concept.

In the transitional phases of EFT, private networks cannot readily be abandoned. In addition to the present impracticality of adapting all private communications links to interface standards, it should be recognized that as with other new technologies, testing and debugging of the packet networks must take place in an implementation phase before a high level of reliability and stability can be achieved. It is expected, therefore, that migration from private financial networks to public networks will take place slowly.

VII. CONCLUSIONS

There has been continuing growth in the development of on-line banking systems in Canada over the last decade. During this period, the base for the evolution of large-scale electronic funds transfer systems has been established. Much of the technology associated with EFT is now in place in Canada. The key force which will accelerate further development will be reduced operating costs associated with the electronic processing of information. The cost of computer processing can be expected to decline. According to H. H. Brune of the Canadian Computer/Communications Secretariat: "Improvements in the price/performance ratio of computer hardware by a factor of ten should be expected...the cost of information and data storage, handling and transfer by physical media other than paper will continue to decline, perhaps causing massive replacements of paper-based information systems before 1985".[61] Further refinements in mini and micro computer hardware will contribute to the availability of low cost data processing power and will make available more powerful, lower cost terminals for EFT applications such as POS systems and remote automated tellers.

A smaller, but significant, improvement by a factor of two or better, is expected to be made in the price/performance ratio in telecommunications services.[62]

The availability of economic data communications facilities which will enable the interconnection of a multiplicity of endpoints is the key integrating component of EFT and POS systems. Canadian data communications facilities are among the most advanced in the world and the new packet switching networks hold great promise for the future development of real-time EFT in Canada. It is expected that over the next five years many of the standards associated with public packet switching will be resolved as the new technology takes hold in the international market-place. As the structure of the computer/communications market-place becomes clearer, equipment manufactures will produce effective X.25 (or a refinement) interfacing systems and the real economies afforded by packet switching

technology will be realized.

The problem of the rationalization of Canadian data communications policy and the derivation of regulatory mechanisms which will serve the public interest, and the requirements of national data communications applications such as EFT for a highly efficient, economical, and reliable data communications environment, is crucial and immediate. At a recent conference on data communications held in Toronto in April, 1978, representatives from all sectors of the Canadian data communications industry including carriers and associations representing users (the Canadian Information Processing Society (CIPS); the Canadian Association of Data Processing Service Organizations (CADAPSO); the Canadian Business Equipment Manufacturers Association (CBEMA); Canadian Industrial Communications Assembly (CICA)), focused on the "uncertain world of regulation" affecting the Canadian computer/communications industry.[63] The central issue to be addressed in consideration of Canadian data communications policy is that of competition. The virtual extension of the telephone monopoly to data communications must be reconsidered in the light of the nature of the industry and user requirements, the technology, and the public interest. The specific issue of interconnection now at hand is but one challenge to present policy. The imminence of large-scale data communications applications such as EFT makes the requirement for a viable data communications policy critical.

It is expected that the next stage in the evolution of EFT in Canada will take place on an <u>inter-bank</u> level. The development of standards for message format and contents is a central requirement imposed by technology to enable institutional exchange of messages and message processing. The growth of EFT will depend upon the ability of financial institutions to reach consensus as to transaction formats, and to modify their present software to process the agreed standards. The creation of the Canadian Payments Association by new banking legislation in 1978 should greatly facilitate devel-

opments in this direction. The Association can undertake the definition of requirements of all aspects of an electronic payments network, and direct its efforts toward the customization of technology now in place to meet these needs.

Co-operation between Canadian banks and retailers has precedent in the credit card system, but co-operation in POS systems will require a much greater degree of co-ordination, becoming attractive to retailers only when cost/benefits are clear. EFT economies, when realized through inter-bank co-operation for electronic transfer systems, can then be extended into a wider sphere.

Experiences with the introduction of other technologies, and the American experience with the introduction of various EFT systems, suggest that consumer issues require careful attention in the planning process.

FOOTNOTES

1. John Hansworth, "Towards On-line Payment Systems the World Over", The Banker (Sept. 1977), pp 56-57.

2. Government of Canada, Computer/Communications Secretariat, The Growth of Computer/Communications in Canada. Draft for discussion, Dec. 1976, p 24.

3. V. G. Cerf and Alex Curran, "The Future of Computer Communications", Datamation, Vol. 23, No. 5 (May 1977), pp 105-114.

4. Leonard J. Simon, "Advances in Electric Funds Transfer", The Banker, (Oct. 1977), pp 79-85.

5. A major study undertaken for 31 major clients including the White House Office of Telecommunications and the U.S. Postal Service. Reported in Datamation (Mar. 1977) pp 164-165.

6. "Clearing House Net Automates Worldwide Funds Transactions", Datacomm User (Sept. 1976), pp 35-36.

7. Canada Department of Communications, Communications Research Centre, Datacom '76: Results of a Survey of Computer/ Communications: Facts and Opinions, Ottawa, April 1977. An analysis of the results of this survey was undertaken by the Computer/Communications Secretariat. Data was compared to other available information and was shown to be of good quality and consistency. Analysis of Computer/Communications Budgets reported in Datacom '76 Survey, July, 1977.

8. Data processing costs included edp personnel, hardware and communications, administrative costs and use of service bureaus.

9. Figures are drawn from Canadian Bankers' Association, Factbook, 1977-78: Chartered Banks of Canada, p 29.

10. See R. H. McLaren's "EPS Study: Canadian Payments System", Working Paper #2 of research project "Policy and Legislative Responses to Electronic Funds Transfer".

11. Canada, Computer/Communications Task Force, Branching Out, Vol. 2, p 56.

12. "Banking and Financial Applications", Computer Data, Vol. 2, No. 10 (Oct. 1977).

13. Ibid.

14. This description of the 3600 System is taken from the following sources: IBM. 3600 Finance Communication System Summary, 4th ed. January, 1975. IBM. 360 Finance Communication System: Factor Folder. 6th ed. February, 1977.

15. "Banking and Financial Applications", Computer Data, Vol. 2, No. 10 (Oct. 1977).

16. William A. Saxton and Morris Edwards, "NCR Seeks Prominence in Distributed Processing with a new Architecture." Canadian Data Systems, (Oct. 1977), pp 27-30.

17. IBM 3600 Factbook.

18. Tony Wiseman, "Numerous Vendors on Hand to Greet Bankers", Computerworld. (May, 1977), pp 16-17.

19. Ibid.

20. "Banking and Financial Applications", Computer Data, Vol. 2, No. 10 (Oct. 1977).

21. See R. H. McLaren's "E.P.S. Study: Canadian Payments System," Working Paper #2 of research project "Policy and Legislative Responses to Electronic Funds Transfer".

22. "News in Perspective:, Datamation Vol. 23 No. 6 (June, 1977), p. 180. Issues of Computer Security and the privacy of data in EFT systems are dealt with in a working paper on this topic: See David H. Flaherty's "Privacy, Confidentiality and Security in a Canadian Electronic Funds Transfer System," Working Paper #5 of research project "Policy and Legislative Responses to Electronic Funds Transfer".

23. Information obtained from Mr. J. McDaniels, General Sales Manager, CN/CP Telecommunications.

24. Arthur Lynch, "Protcols Key to Communications Future", Computerworld, (Sept. 26/77), p 31.

25. Sources: A. Rolston and C. Meek, Encyclopedia of Computer Science, New York: Petrocelli/Charter, 1976; "How the University Views the Future", Canadian Datasystems (April, 1976), pp 20-28; A.M. McMahon, "A New Philosophy in Data Networks", Canadian Datasystems (June 1976), pp 41-44; Stuart L. Mathison, "Packet Net Seen Best Option", Computerworld (Nov. 29/76), pp 3, 8.

26. "Should Packet Networks Offer Datagram Service?" Datamation (Oct. 1977), pp 154-155.

27. Ibid.

28. Telephone interview with O.W. McAleer, Asst. V.P. Computer Communications Planning, Bell Canada; Mr. McAleer described the banking community's response to the idea of Banknet as extremely conservative.

29. "Executives in the News", Executive (Jan. 1977).

30. O. W. McAleer.

31. Ronald Frank, "Hundreds of Terminals Operating on Datapac" Computerworld (August 29/77), p 24. Andrew McMahon, vice-president of the Computer Communication Group, Bell Canada, said that he could not give Computerworld the total number of CPU's now on the network for competitive reasons.

32. R.W. Evans Associates, "Planning for Packet Switched Services" EDP In-Depth Reports, Vol. 5, No. 12, August, 1976.

33. Source: Canadian Datasystems, Vol. 9 No. 8 (Sept. 1977), p 67.

34. Nancy French, "Transnational Processing Cited as Canadians Bane" Computerworld (August 15/77) p.10. (Report of an address to the International Federation for Information Processing Congress 77 by the Minister of State for Science and Technology, J. Hugh Faulkner).

35. "Datapac Interconnection Rates Cited With CRTC". Canadian Data Systems 10 (March, 1978), pp 71.

36. Guy Carleton, "Terminals and Interface Procedures Need Study in Protocol Talks", Computer Data (June, 1976), pp 35-37.

37. A recent decision by the Federal Cabinet overruled the CRTC decision against a proposed agreement under which Telesat Canada would become a member of the TCTS (reported in The Globe & Mail, Nov. 4/77). Such a merger will strengthen the competitive advantage of the telephone companies in the satellite communications field; the CRTC concluded that "the advantage to TCTS members inherent in the situation to be created by Telesat's membership...raise a substantial likelihood of undue advantage or preference". (Drew Millar, "Cabinet Decision Lets Telesat Join TCTS:, Computing Canada 3 (December 1977):3). In a radio interview (CBC, Nov. 17/77) Federal Communications Minister Jeanne Sauvé defended the government's decision on the grounds that Telesat was not conceived of as a competitor to the carriers.

    Canadian Pacific Ltd., a shareholder in Telesat, has initiated a lawsuit alleging that by joining TCTS, Telesat has entered into a partnership, thus contravening the Telesat Canada Act. The Consumers Association of Canada is also undertaking a lawsuit aganist the merger. (Computing Canada 3 (Dec. 1977): 1, 3-5).

    Data communication applications utilizing satellite communications links are emerging worldwide for various applications including EFT. National Bank Americard, Inc. utilizes dial-up satellite telephone circuits for domestic traffic with Alaska for a "value transmission system" and plans on extending this service worldwide.

38. Source: CRTC, Annual Report '76-77, Ottawa: Minister of Supply and Services, 1977.

39. Canada, Computer/Communications Task Force, Branching Out, Vol. 2, Ottawa, 1973.

40 Ibid., p 13.

41 Ibid., p.15.

42. "Standards Set for Terminal Connection to Carrier Networks", Canadian Datasystems (March 1976), p 37.

43. Branching Out, p 15.

44. Canada, House of Commons, An Act Respecting Telecommunications in Canada, Bill C-43, 20th Session, 30th Parliament, 1976-1977.

45. Phil Hirsch, "Data Communications Report", Computer Data 3 (April 1978), pp 49.

46. Ibid.

47. CRTC Annual Report, 1976-1977, p 35.

48. J. McDaniels, Gen. Sales Manager of CN/CP reported that CN/CP dominates the market in the west, while TCTS dominates in the east.

The survey undertaken by the Communications Research Centre indicated a much higher proportion of TCTS usage; among 74 "leading edge" data communications users, 55% use only TCTS, 15% use only CN/CP, and 30% use both major carriers.

49. Gordon D. Hutchison, "Will CN/CP Be Able to Compete in Data Comms Market?" Canadian Datasystems 10 (May 1978), pp 46-47.

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52. Bank of Nova Scotia, Intervention in Canadian Radio-Television and Telecommunications Commission Re: CP Telecommunications, Inter-connection with Bell Canada, 1977.

53. Swift, General Information (1977). Mimeographed. Peter N. Drummond, Swift: Society For Worldwide Interbank Financial Communication, Paper presented at the National Security Conference of Canadian Financial Institutions, November 15-16, 1977.

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55. Harold Armitage, "Faster Than a Speeding Bullet", Canadian Banker and ICB Review, 83:3 (May/June, 1976), p 20.

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60. Science Council of Canada, A Trans-Canada Computer Communications Network, Ottawa, Information Canada, 1971.

61. H. H. Brune, "The Social Implications of Information Processing." Paper Presented March 14/78 at the University of Waterloo. Ottawa: Computer/Communications Secretariat, 1978, p. 11.

62. *Ibid.*, p.11.

63. "Canada: World Leader in Communications," *Computer Data* 3 (May, 1978), pp 18-23.